AWARE

NASA Weather Accident Prevention Project Annual Review

May 23-25, 2000

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Outline

- Program background
- Objectives
- Technical accomplishments
  - Information-fusion architecture
  - Information visualization
  - Leveraging other programs
  - Technical trade-off issues
- Plans for the next year
  - Aviation weather-information portal with easy-to-use decision analysis/situational awareness functions
- Summary
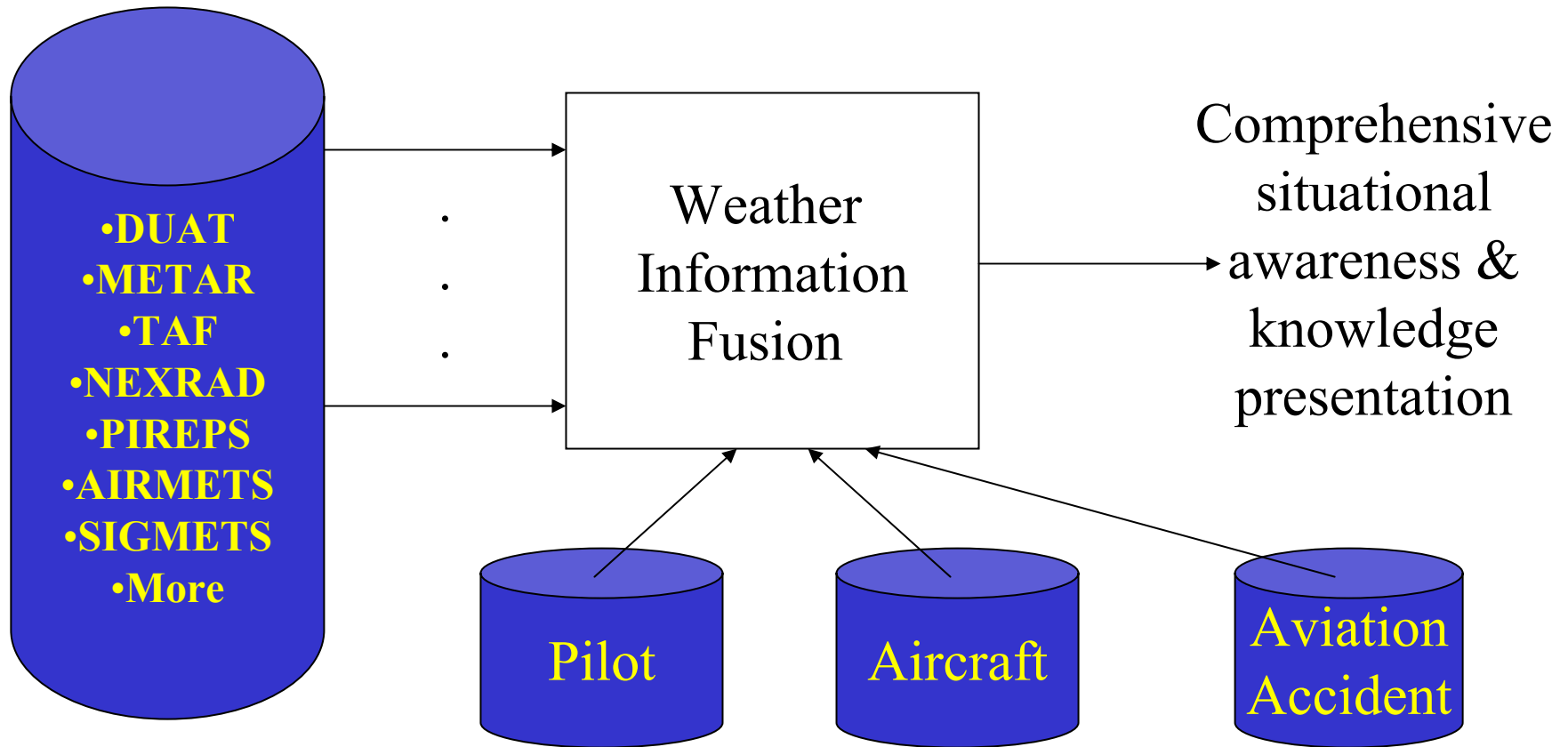
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Program Background

- Supported by the NASA under Contract No. NCC1-290
- NASA Program Manager: Anthony Busquets
- Funded as a topical R&D project under the NASA AWIN program
  - Rockwell Science Center, Rockwell Collins, and NASA
  - Developing a proof-of-concept prototype, not a commercial system
- September 1998 - September 2002

Objectives

- Weather information filtering and situational awareness using advanced decision-support algorithms coupled with human factors analysis


•DUAT
•METAR
•TAF
•NEXRAD
•PIREPS
•AIRMETS
•SIGMETS
•More

. . .

Weather Information Fusion

Comprehensive situational awareness & knowledge presentation

Pilot

Aircraft

Aviation Accident

Technical Accomplishments

- Official project Web site: http://www.awin.org

- AWARE system architecture design (11/30/98)

- NEXRAD kinetic analysis (2/15/99)

- METAR interpretation and decision analysis (4/30/99)

- Icing products integration (9/30/00)

- VFR preflight briefing design (12/31/00)

- VFR summary display (3/31/00)
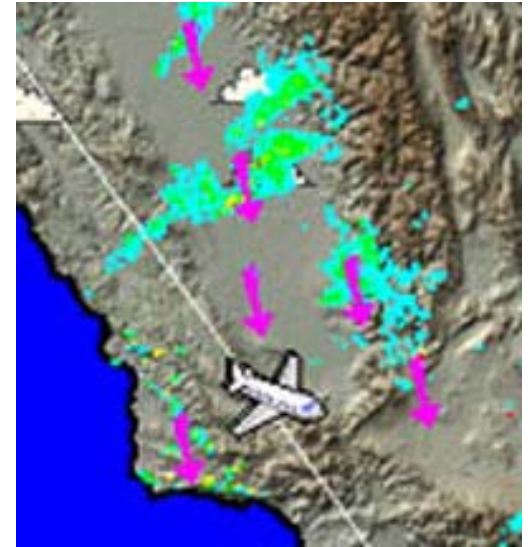
Current Status
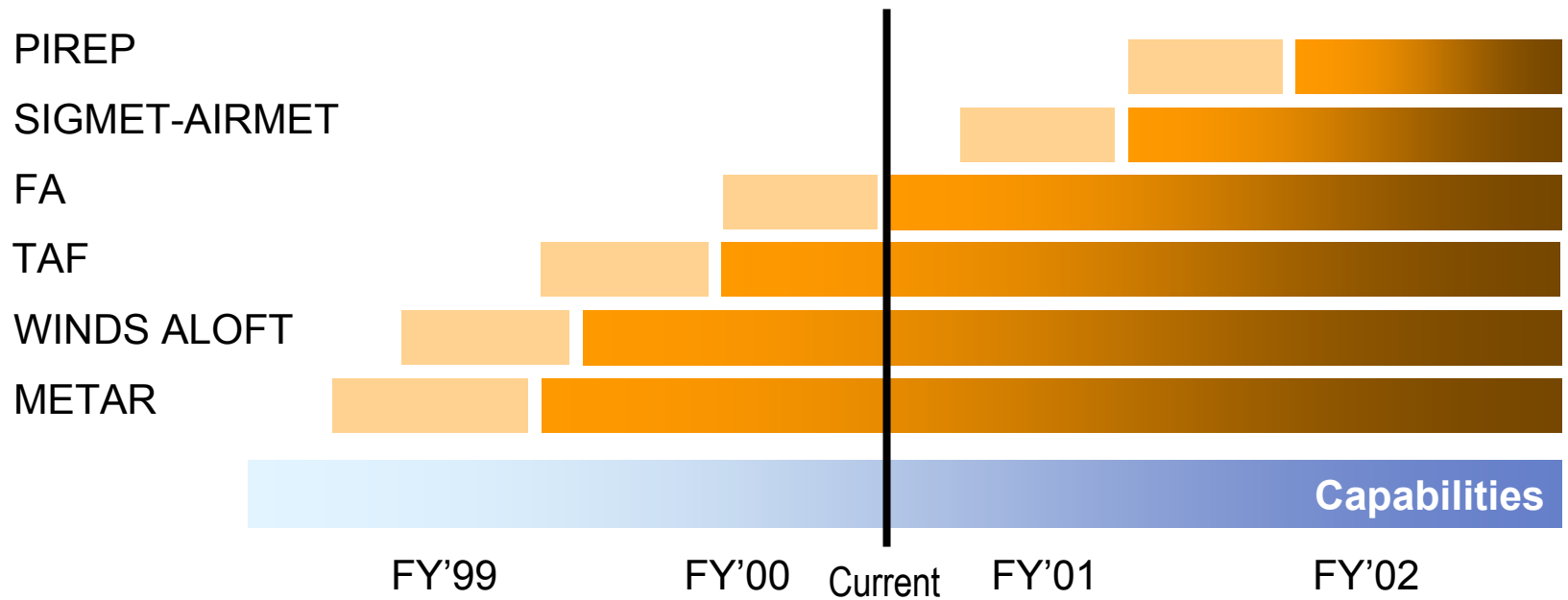
Weather Information Fusion

Inputs:
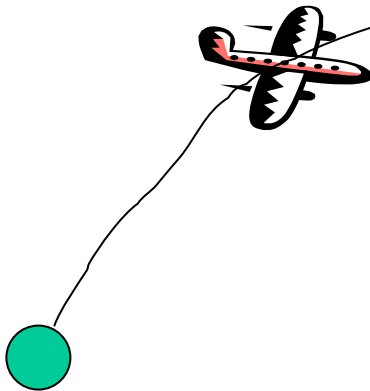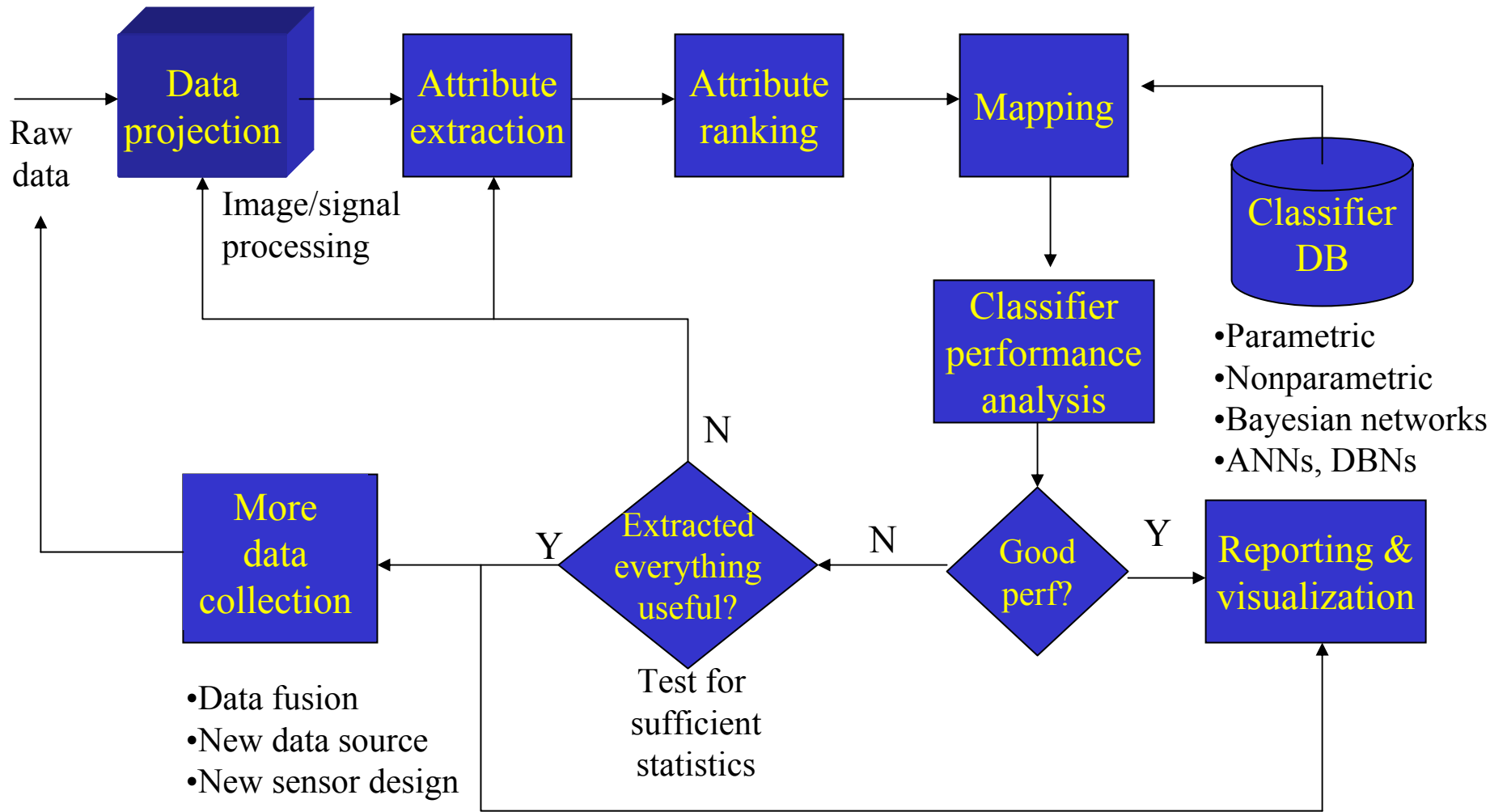- Onboard sensor data
- Uplinked weather data

Output:
Hazard index
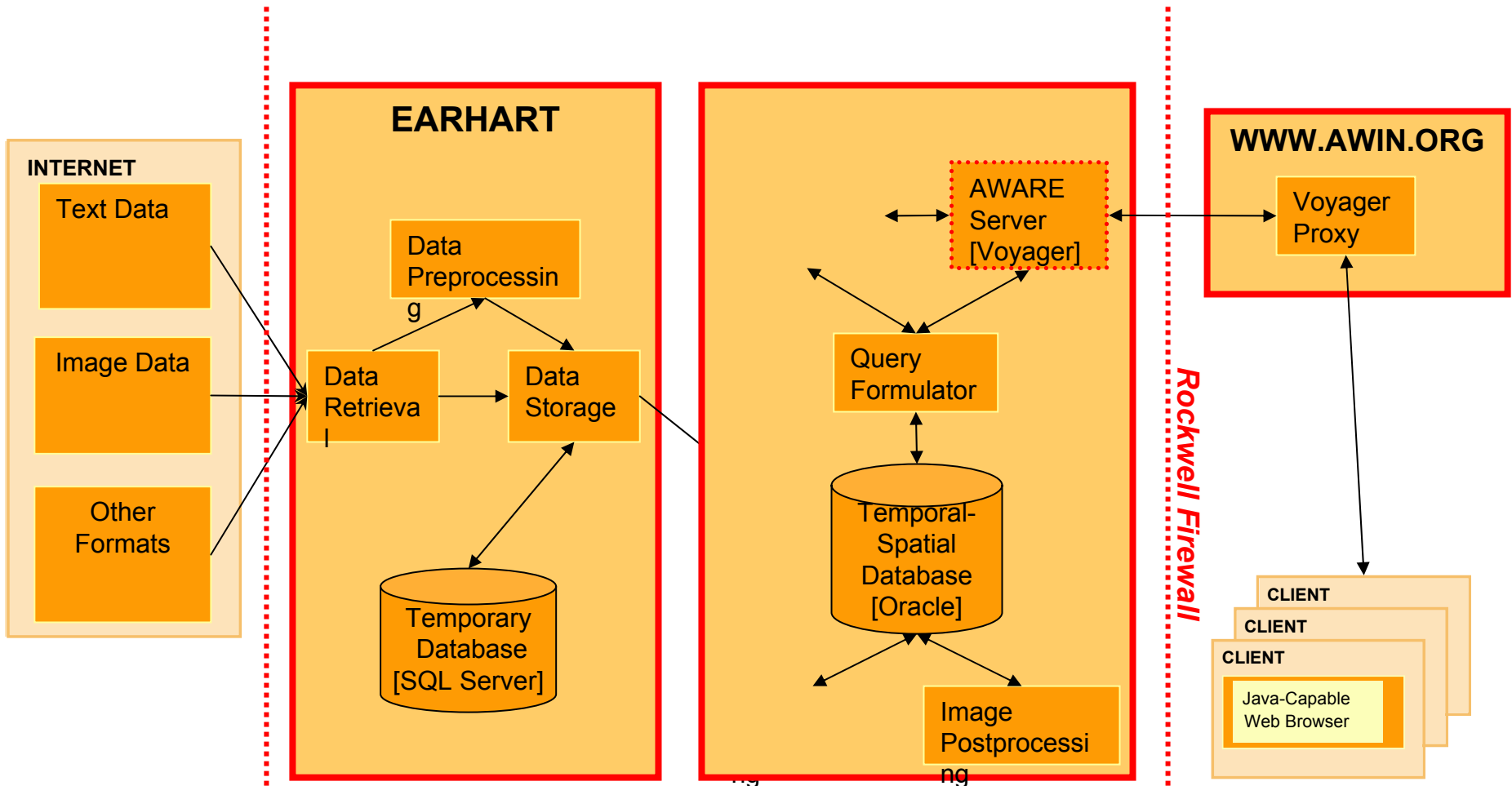as a function
of time

Processing:
- Hazard object detection/clustering
- Attribute extraction
- Severity of hazard calculation
  - Hazard analysis
  - Pattern classification
  - Fusion (Bayesian, Fuzzy, D-S)
- Display formatting

Information-Fusion Architecture for Decision-Support Analysis

System Architecture

AWARE Weather Briefing

VFR Summary Display (3/31/00)
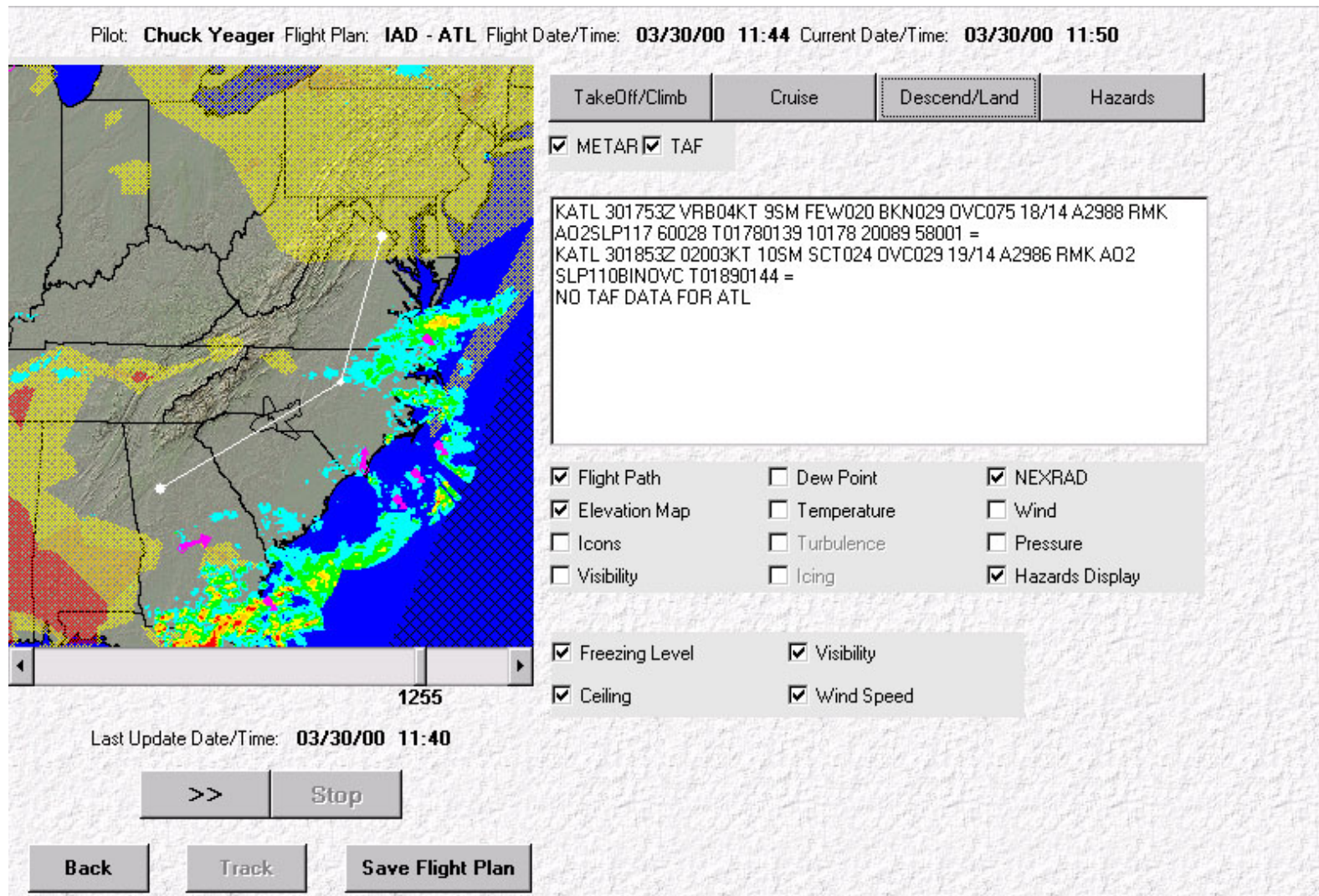
Information Visualization

Turbulence overlay
from NCAR forecasts

Direction &
velocity of
winds aloft

Flight path

Cloud
cover
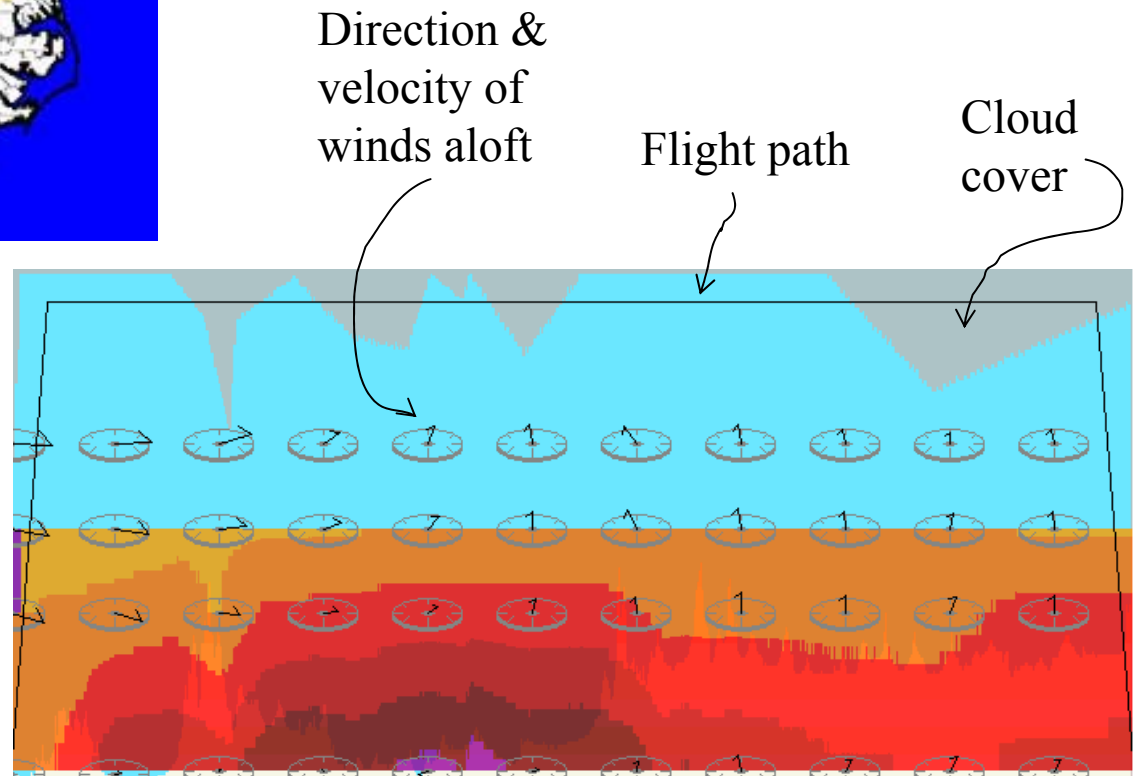
Vertical flight profile using METAR and flight data plan

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Data Processing

Parsing from text data

```
AIRMET ICE...WA OR CA
FROM TVL TO FAT TO BIH TO RNO TO TVL
LGT OCNL MOD RIME ICGIC BTN 070
AND FL200.  CONDS SPRDG SLOLY
SEWD AND CONTG BYD 09Z THRU 15Z.

AIRMET TURB...WA OR CA ID MT
FROM EHF TO SMX TO SBA TO VTU TO PMD
TO EHF
OCNL MOD TURB BLW 120 DUE TO MOD WLY
FLOW.  CONDS SPRDG EWD AND
CONTG BYD 09Z THRU 15Z.
```

XML

Weather Event Database

Icing_Event
• Unique_ID:
• Spatial_Extent:
• Temporal_Exten
• Type: Rime
• Severity:
• Direction:
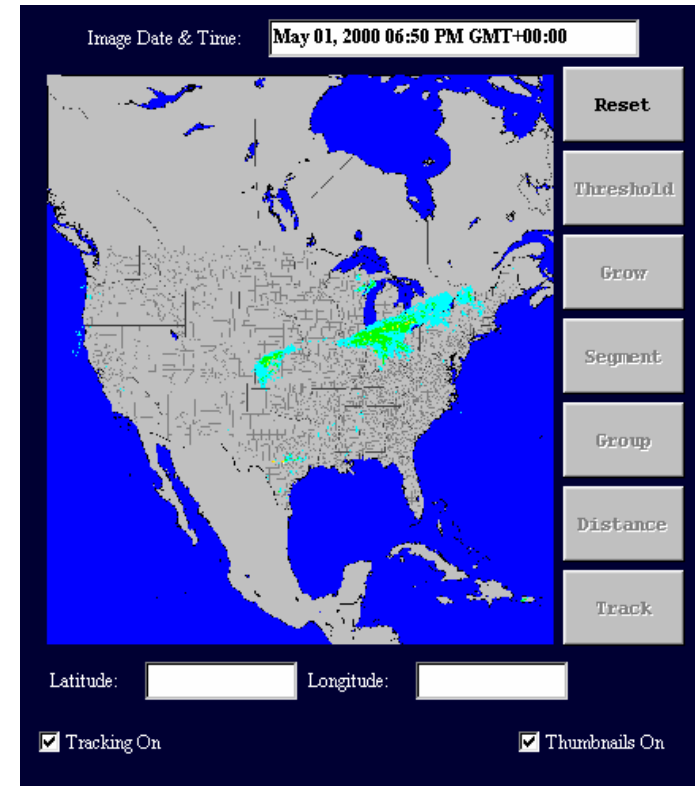• Velocity:
• Supercedes:

Turbulence_Event
• Unique_ID:
• Spatial_Extent: …
• Temporal_Extent: …
• Type: Clear air
• Severity: Moderate
• Direction:
• Velocity:
• Supercedes:

Data models

| Image Date & Time: | May 01, 2000 06:50 PM GMT+00:00 |

Reset
Threshold
Grow
Segment
Group
Distance
Track

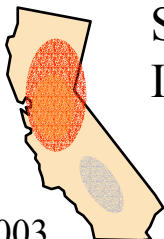Latitude: ____   Longitude: ____

☑ Tracking On   ☑ Thumbnails On

Image/signal processing

Sufficient statistics analysis &
Information filtering for planning

Flight planning assistance &
Decision-support analysis

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Key Trade-off Issues

- Server- vs. client-side programming
- Migration from Informix to Oracle
  - Spatial cartridge vs. Datablade
  - Data storage: sufficient statistics?
- Bayesian network implementation using Hugin
  - Where is data coming from? Data mining to assign hard numbers to various convective weather events
  - Complement BN with classical hazard analysis and pattern classification preprocessing
  - Automation vs. trust
- XML eliminating or reducing the need for text parsing (Weather Observation Definition Format at SPAWAR)
  - Military TAF vs. civilian TAF

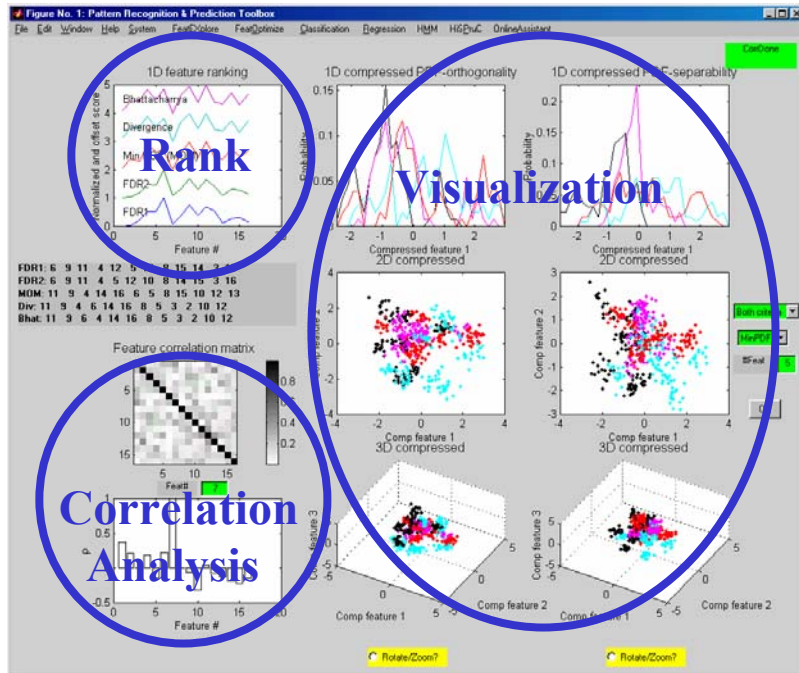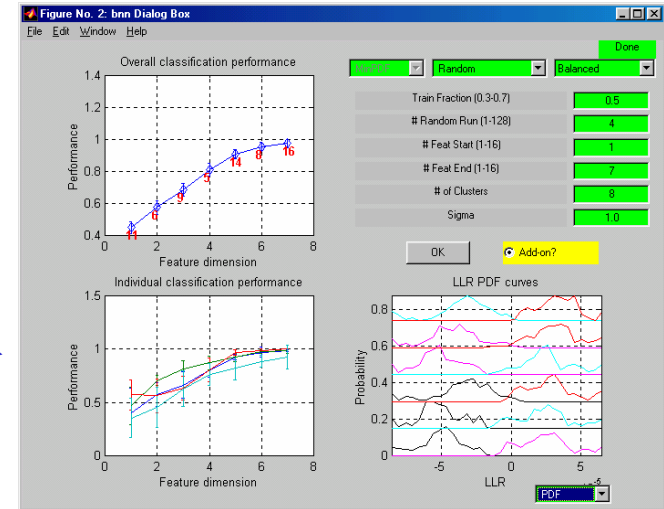# Leveraging Other Programs

- ONR mine countermeasure: Data-mining toolbox along with various preprocessing algorithms (wavelet, image processing, and transformation) for information filtering and fusion

- DARPA programs on the use of Bayesian networks for information fusion and resource allocation

- IR&D programs on creating scalable, database-backed Web sites

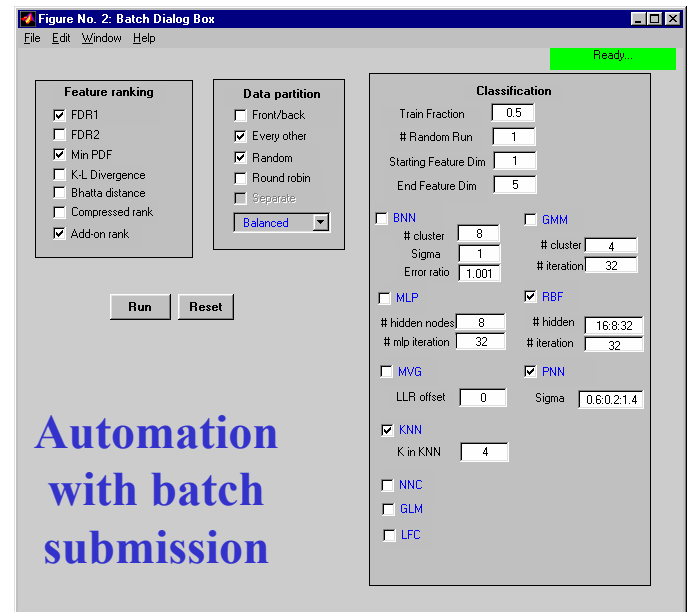Rockwell Collins   Rockwell Science Center

Data-Mining Toolbox

Rank

Visualization

Correlation Analysis

Performance analysis

Clustering

http://www.killmine.com
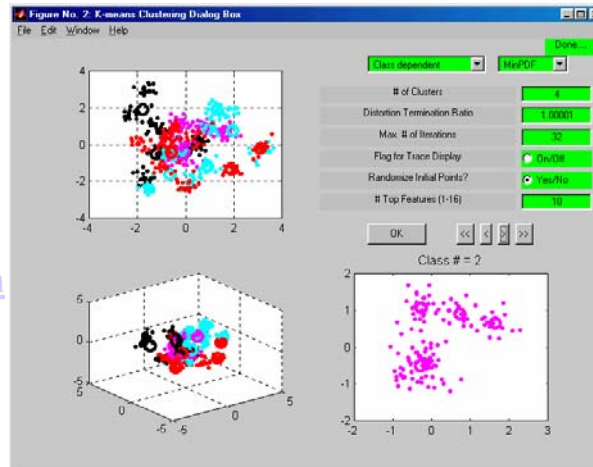
Automation with batch submission

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Information Fusion

S.Temp

DP spread

Move

Dew P.

LAS

Pre-flight danger level

Uplinked data

EWxR (WxR+NEXRAD)

Convective weather attributes*

E-PIREPS

CAT LIDAR & other sensors

Turbulence

Radar shadow

•Height
 Gradient
 Shape
 Reflectivity
 Wavelet coefficients
 Velocity vector
All extracted from
image/signal
processing algorithms

•A/C location
•FMS data
•Constraints

Hazard SA

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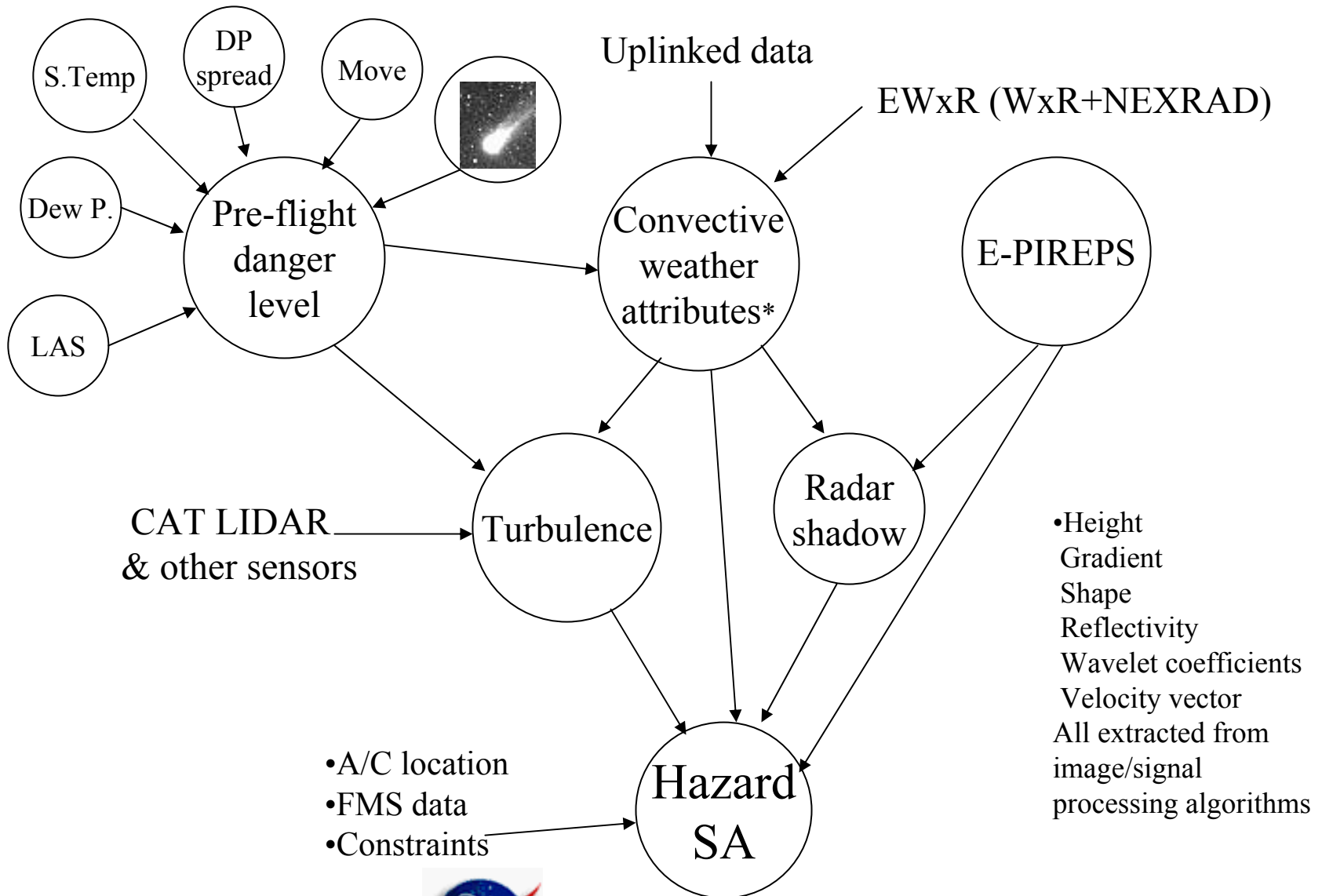
Financial Status: Spent vs. Actual

AWARE 2000 6 Month spending

Slightly over budget due to one-time NCAR subcontract which will be spread over multiple milestones

Legend:
- ROK Actual
- ROK Planned
- NASA Actual
- NASA Planned
- Total Cost Actual
- Total Cost Planned

Y-axis: $ Spent (0, 50000, 100000, 150000, 200000, 250000)

X-axis: Month (Oct., Nov., Dec., Jan., Feb., Mar.)
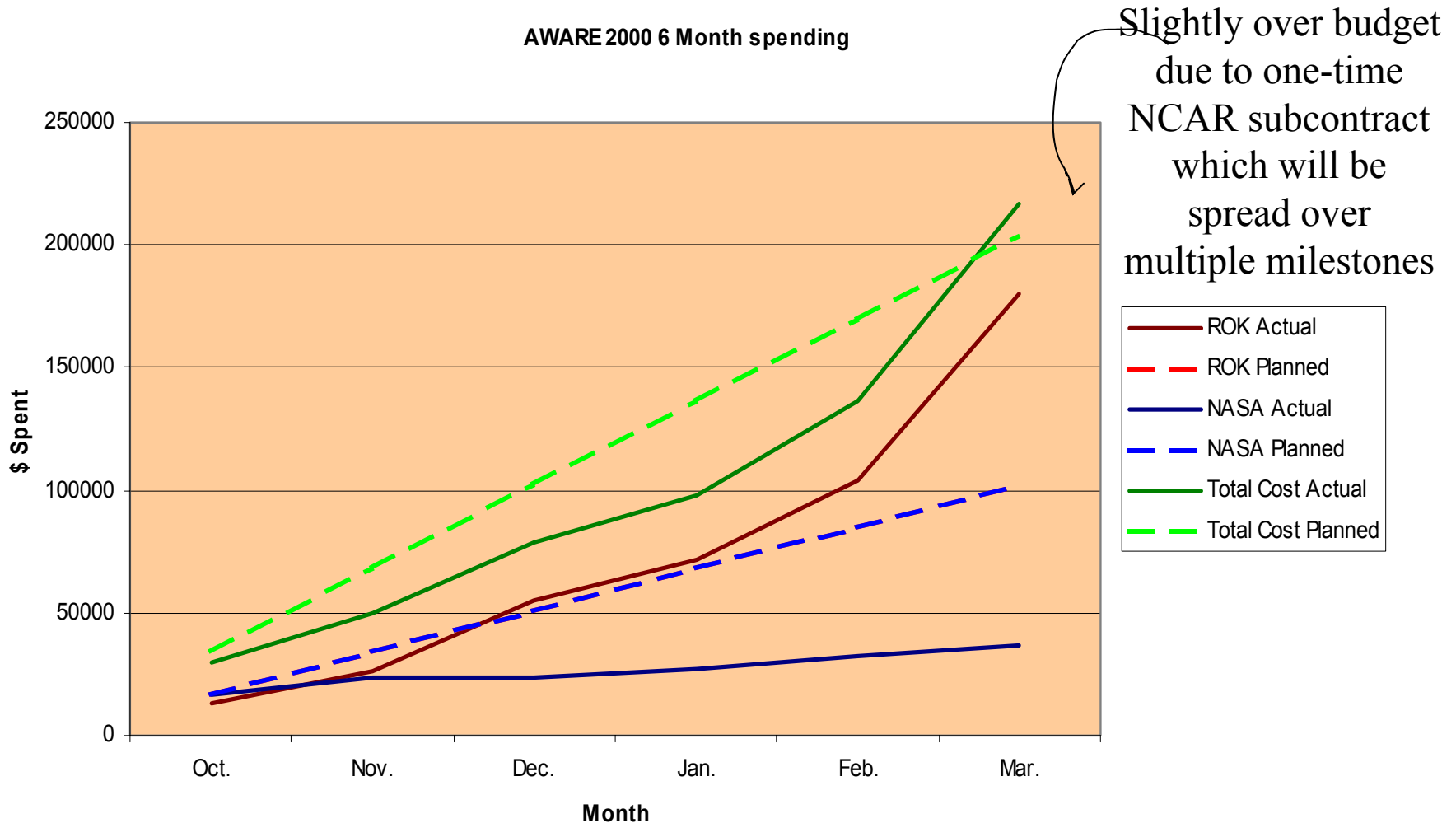
Roadmap

- SIGMETS/AIRMETS
- VFR preflight briefing integration
- PIREP integration
- IFR preflight briefing/display
- In-flight architecture
  - In-flight decision support
  - EWxR integration
  - Usability study
  - Integration in NASA 757
- IFR in-flight briefing integrated demo

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Summary

- Identification of suitable databases & data models
- Information filtering and fusion
- How to find the right spectrum between raw data presentation and decision making for pilots (*The Future of Air Traffic Control* by NAP)
- Automated data collection with the totally connected world
- How to identify the point of diminishing returns with sufficient statistics analysis

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